RESISTANCE SCREENING CENTER

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Screening for Fusiform Rust Resistance as a Service for Tree Improvement Programs

United States Department of Agriculture

Forest Service Southern Region

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Services of the Resistance Screening Center

Who Uses the Center - And Why

The Resistance Screening Center evaluates pine seedlings for resistance for fusiform rust[1] as a service to tree improvement specialists, seed orchard managers, scientists, and others in government agencies, research institutions, and private industry. Testing enables clients to obtain information on the relative resistance of their pines, in much less time than is possible in field progeny tests. The Center provides information on loblolly pine resistance in 11 months, and slash pine resistance in 8 months, whereas field progeny tests require 4 or 5 years. By using information from these tests, trees producing rust-resistant progeny are identified.

Who Operates the Center — And How

The Center is operated by the Forest Pest Management Staff of the USDA Forest Service's Southern Region, State and Private Forestry. The Center is located at the Bent Creek Experimental Forest near Asheville, NC.

The Center employs the controlled basidiospore suspension (CBS) system developed by the Forest Service's Southeastern Forest Experiment Station. Pine seedlings are uniformly inoculated using a carefully controlled inoculum density and a mechanized spray inoculation system.

The Threat of Fusiform Rust

The Resistance Screening Center was established in 1973 to meet the threat to southern forests from fusiform rust. This fungus-caused disease is considered the most destructive forest disease in the South. The fungus is widely distributed from eastern Maryland to Florida and west to Texas and southern Arkansas. The severity of the disease varies geographically. In some high-hazard areas it is impossible to grow susceptible trees to harvestable size. About 2.5 million acres have at least 50 percent of the trees affected, with an annual increase of about 3.5 percent per year. About 13 million acres have at least 10 percent of the trees affected. Annual losses attributed to the rust are estimated at $49 million in stumpage per year.

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[1] Fusiform rust is caused by *Cronartium quercuum* (Berk.) Miyabe ex Shirai f. sp. *fusiforme* (Cumm.) Burds. et Snow.

Strategy: Increase Genetic Resistance

Although the disease can be controlled in pine nurseries by fungicides, the use of chemicals to prevent or control the rust in natural or planted stands is not economical. Fortunately, some pines have a natural resistance to fusiform rust. This genetically controlled resistance offers a method to reduce or minimize rust losses. Researchers have identified loblolly and slash pine families that have a high proportion of trees with much more resistance to rust than is found among pines in general. Resistance screening serves to test pine progeny as fast as possible to accelerate the process of identifying resistant parents.

Resistance Screening Process

The screening process is coordinated with the life cycle of the fungus. For a detailed life cycle, unfold the leaflet completely and look at the reverse side. The life cycle involves two hosts. The aeciospores produced on pines infect only oaks. Basidiospores of the fungus are produced on oaks, and infect only pines. Biological materials from both hosts are kept on hand at the Center at all times so that testing can be done year-round. Aeciospores from the fusiform rust fungus are collected and processed for long-term storage each spring. Spores are collected from both loblolly and slash pines in 20 collection areas across the South. In addition, acorns of northern red oak are collected and stored each fall.

The primary steps in the screening process are:

1. Germinate and grow pine seedlings from different seed sources. A seed source may represent an open pollinated family, controlled cross, bulk collection, etc.

2. Inoculate oak host with aeciospores, collected from infected pines, to produce basidiospores, which will infect pines.

3. Harvest basidiospores from infected oak leaves and prepare spore dilutions of standard density. Critical control and standardization of the inoculum spray is achieved by using an electric particle counter similar to the type used by hospitals to obtain blood cell counts. Without this modification of a medical device, the screening process would be less accurate and more difficult to conduct.

4. Inoculate 6-week-old pines using an automated mechanical spray system, and incubate at a temperature and humidity optimum for infection. The automated spray system is designed to expose each seedling to the same amount of inoculum (spores).

5. Evaluate pine seedlings for multiple symptom types after a period of time sufficient for symptom development.

In the standard test, three trays of 20 seedlings from each seedlot are inoculated. The process is then repeated on a second day. At the same time, the Center's own standard check seedlots (including resistant and susceptible seedlots) are inoculated for comparison with the client's seedlings. The inoculum (aeciospore) source area is selected by the client according to seed source, planting destination, or other criteria. Modifications of the test design for research purposes may be desirable and can be accommodated within the constraints of the resistance screening process.

Tests for fusiform rust provide conservative estimates of the proportion of resistant seed sources. Statistical analysis of the results are included in reports to clients to aid in determining if there are meaningful differences between seed sources (figure 1). These analyses also provide a measure of the consistency of inoculation procedures, and indicate a high level of repeatability.

Figure 1.--Index of relative resistance

RANK	SEEDLOT	INDEX VALUE
RES. CK	CHECK 1	325
1	FAM 3	310
2	FAM 7	300
3	FAM 1	275
4	FAM 9	274
5	FAM 8	250
6	FAM 5	221
7	FAM 6	212
8	FAM 2	156
9	FAM 4	112
SUS. CK	CHECK 2	90

Related Screening Services

Although the Center's services are based on scientific principles, the staff does not conduct research. However, the Center frequently cooperates with scientists who wish to conduct parts of their research with the aid of the Center's facilities. Slight modifications in the screening process can help scientists conduct tests designed to answer questions concerning such things as the nature of variation in the rust fungus and the effectiveness of fungicides.

How to Submit Seed for Resistance Screening

Anyone who would like to have loblolly or slash pine seed screened for resistance to fusiform rust should submit sound seed of good quality. Because 120 seedlings per seedlot are required for screening, a minimum of 250 seeds per seedlot should be submitted. This service is offered to clients for a fee. Clients are billed when the seedlots are scheduled for screening. Healthy (noninfected) seedlings are available to clients at the end of the tests.

Tree improvement cooperative members should send seedlots through their cooperative program:

North Carolina State University Cooperative -
Dr. Robert J. Weir
School of Forest Resources
North Carolina State University
Raleigh, NC 27607

University of Florida Cooperative - Dr. Tim White
School of Forest Resoures and Conservation
University of Florida
Gainesville, FL 32611

Western Gulf Cooperative - Dr. W. J. Lowe
WGFTIP
c/o Forest Science Laboratory
College Station, TX 77843

Others should send seed directly to the Resistance Screening Center.

For additional information, contact:

USDA Forest Service
Southern Region, FPM
Resistance Screening Center
Rt. 3, Box 1249A
Asheville, NC 28806

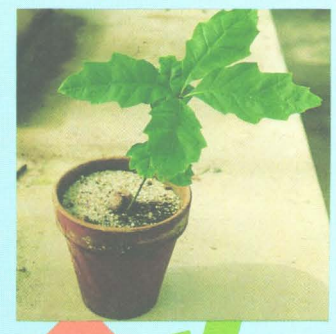
FUSIFORM RUST

PYCNIA

1. AECIOSPORE COLLECTION

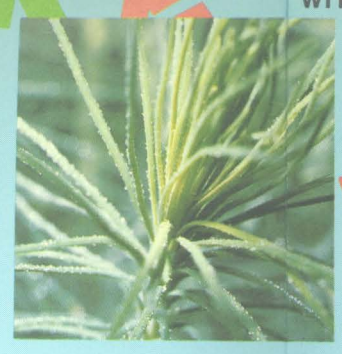
AECIA

2. OAK INOCULATION



3. TELIA PRODUCTION

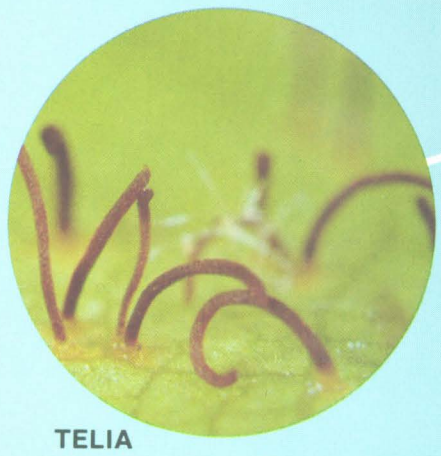
4. PINE INOCULATION WITH BASIDIOSPORES



5. INFECTION EVALUATION

THE SCREENING PROCESS

The screening process parallels the life cycle of the fusiform rust fungus. (1) Aeciospores are collected from the forest each spring. (2) When a resistance screening test is initiated, tender oak leaves are inoculated with aeciospores. Urediospore production is by-passed in the screening process, but, (3) telia form on the underside of the oak leaves. Basidiospores are induced to form on the telia in the laboratory and they are used (4) to inoculate pines. (5) Symptoms develop on the pine seedlings and seedling responses to infection are evaluated.



TELIA

UREDIA

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Southern Region-State and Private Forestry
USDA Forest Service
Route 3, Box 1249A
Asheville, N.C. 28806

LEGEND

RESISTANCE SCREENING PROCESS

LIFE CYCLE OF FUSIFORM RUST

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